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ABSTRACT

During the 1960's a growing body of experimental evidence suggesting that early malnutrition could affect the development and the functioning of the brain was translated into a concern that nutritional deprivation might be producing permanent mental retardation among "disadvantaged" children. The purpose of this paper is to show, through a review of the relevant literature, that such a concern, while humanitarian in its inspiration, is misplaced. The bulk of the available evidence appears to indicate that malnutrition produces what might be called mental retardation only when it occurs in early infancy and is both severe and prolonged. Even under such circumstances, rehabilitation appears to be possible if the children in question are provided with both adequate food and appropriate intellectual stimulation. In this country, however, such serious malnutrition is highly unusual--American poor children are much less likely to be severely malnourished than they are to be chronically hungry. Though there is little experimental evidence about the effect of children's hunger on their classroom performance, chronic hunger will obviously sap a child's energy and attention. Moreover, since it is a mark of poverty, it will also stigmatize him. Moreover, the kinds of children exposed to chronic hunger in the U.S. are also likely to have experienced other stresses associated with environments which may be both physically and mentally impoverished. Which makes it unlikely that the effect of nutrition alone on mental development will ever be teased out experimentally. In the richest country in the world no child ought ever to sit hungry in the classeoom. (Author/JM)

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NUTRITION AND MENTAL DEVELOPMENT

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INTRODUCTION

During the 1960's a growing body of experimental evidence suggesting that early malnutrition could affect the development and the functioning of the brain, was translated into a concern that nutritional deprivation might be producing permanent mental retardation among "disadvantaged" children. The purpose of this paper is to show, through a review of the relevant literature, that such a concern, while humanitarian in its inspiration, is misplaced. The bulk of the available evidence appears to indicate that malnutrition produces what might be called mental retardation only when it occurs in early infancy and is both severe and prolonged. Even under such circumstances, rehabilitation appears to be possible if the children in question are provided with both adequate food and appropriate intellectual stimulation.

In this country, however, such serious malnutrition is highly unusual--American poor children are much less likely to be severely malnourished than they are to be chronically hungry. Though we have little experimental evidence about the effect of children's hunger on their classroom performance, chronic hunger will obviously sap a child's energy and attention. Moreover, since it is a mark of poverty, it will also stigmatize him. These effects of hunger may be as debilitating to the school performance of a child in the affluent U.S. as

more severe malnutrition is to a child in a society in which malnutrition of some degree is the social norm. Moreover, the kinds of children exposed to chronic hunger in the U. S. are also likely to have experienced other stresses associated with environments which may be both physically and mentally impoverished. Which makes it unlikely that the effect of nutrition alone on mental development will ever be teased out experimentally.

Given the fact, however, that even among severely malnourished children food alone is not enough to achieve rehabilitation, the role of the school in regard to educating poor children must be what the role of the school ought always to be--to see to it that each child is given learning opportunities appropriate to his needs--with the added proviso that in the richest country in the world no child ought ever to sit hungry in the classroom.

I NUTRITION AND MENTAL DEVELOPMENT

> The responses to environmental stimuli made by the organism during the very early phases of its development, including the intrauterine phase, deserve special emphasis because they exert profound and lasting effects on the physical, physiological, and behavioral characteristics of the adult. Often, indeed, such effects are so lasting that they can be regarded as a general expression of biological Freudianism. . . Time is therefore an essential factor in the evaluation of environmental effects. By acting on the child during his formative stages, the environment shapes him physically and mentally, thereby influencing what he will become and how he will function as an adult. . .
>
> Dubos, 1968

Like a number of questions which have engaged educators in this country over the past two decades, the question of whether and how nutrition might influence behavior and psychological development has come into prominence because of an increasing sense of concern over the failure of the existing educational system to bring to acceptable levels the academic achievement of certain large groups of children in our society.

Malnutrition, as a possible factor in this failure, came to the forefront of public attention in this country late in the 1960's as a result of the convergence of three currents of concern. The first of these was the discovery--more properly the rediscovery--of poverty-induced hunger in the United States, beginning with the well-publicized trip of Robert Kennedy and other Senators to the deep South in 1966. That trip, and

its aftermath of official concern and indifference toward the problems of finding and feeding the hungry poor in America were chronicled in two widely circulated reports (Hungry Children, 1967; Hunger, U. S. A., 1968), a television documentary (CBS Reports, 1969), and finally a popular book on the politics of hunger in America (Kotz, 1969). The concern about hunger generated during this period also resulted in the establishment of a special Senate Select Committee on Nutrition and Human Needs to investigate the scope of the problem and suggest programs to resolve it (Nutrition and Human Needs, 1968); it helped stimulate a 1969 White House Conference on Food, Nutrition and Health (White House Conference, Final Report, 1970) and resulted in a mandate from Congress to the Executive Branch to conduct a nutrition survey in order to determine the extent of hunger and malnutrition in the United States. The results of that survey, which confirm the existence of high rates of nutritional deficiency among certain groups of poor children, have only recently been released (U. S. Department of Health, Education and Welfare--The Ten-State Nutrition Survey, Highlights, 1972).

Meanwhile, outside the U. S., the growing political importance of the Third World Nations was bringing increased attention to the existence in these countries of widespread and often severe nutritional deprivation affecting literally millions of children. With improved medical care, mortality

among such children declined; observation of the survivors led a number of researchers to wonder whether the same nutritional stresses which often resulted in permanently retarded physical growth in such children might not also be condemning them to a permanently limited intellectual potential. The review by Coursin (1965) included here, and the reports of two major conferences (National Academy of Science, 1966, Deprivation in psychobiological development, 1966) define the parameters of such concern as of the mid-1960's; the 1972 Barnes paper briefly chronicles the growing interest in this question among nutrition researchers throughout the latter half of the decade.

In this country, the final current which fed into professional concern over the possible intellectual implications of nutritional deprivation was the growing awareness that programs of "compensatory education" designed to make up to children "disadvantaged" by what was viewed as an inappropriate acculturation process, had not succeeded in overcoming the educational failure of such children.

This apparent failure of compensatory education ("apparent" because, many critics argued, compensatory education had been given only a hasty, not a careful test) helped lead in the late 1960's to the re-emergence of the notion of "genetic inferiority" as an explanation of why it was that a disproportionate number of our academic failures were not only poor, but poor and black (Jensen, 1969).

The apparent failure also led, however, to a re-examination of the assumption regarding the nature of the handicap that poverty imposed on poor children, a re-examination which called attention to the often ignored fact that poverty is more than a psychological and social disadvantage --that poor children are additionally exposed to a variety of potentially handicapping physical hazards among which nutritional stress is prominent (Birch & Gussow, 1970).

Thus it was that 1) the rediscovery of hungry poor in the U. S.; 2) the worldwide concern for the mental aftereffects of severe early malnutrition; and 3) the failure of what seemed to be our best efforts to help poor children learn--these three events came together to provide fertile ground for the growth of the notion that the reason poor children in this country did not learn as well as children who were not poor was because they were, or had been, hungry.

The public "popularity" of the problem peaked around the end of the 1960's with the publication of numerous short papers and several longer texts which in one way or another summarized the issues as they were understood to that time. One volume documented the proceedings of a landmark conference on Malnutrition, Learning and Behavior held at MIT in March of 1967 (Scrimshaw & Gordon, 1968); one was a compilation of evidence linking poverty to mental retardation (Hurley, 1969) and the third was a careful look at the contribution of various physical

hazards of poverty to the "disadvantage" which poor children faced in their educational endeavors (Birch and Gussow, 1970). These texts which summarize much of the data, most of the understandings, and some of the misunderstandings of the links between hunger, malnutrition and mental functioning as they stood at the close of the decade, represent a baseline point for this bibliography. The material considered has been limited largely to the period since 1969 when the literature search for the most recent of these texts was completed. And though certain earlier papers will be cited here, those interested in a thorough review of the underlying issues should consult these volumes. At least four additional review papers from this period have been included (Eichenwald & Fry, 1969; Frisch, 1970; Winick, 1970; Gussow, 1970), since they summarize for the interested reader the status of knowledge at the opening of the present decade in brief and easily accessible form.

Just how is nutritional status thought to be linked to mental functioning? The paper by Widdowson (1972) provides a broad and brief historical overview of the relationship--including a consideration of the role of the brain in regulating hunger and satiety, as well as the effect of hunger or various kinds of nutritional deprivation on the brains and behavior of experimental animals and people. Of particular interest (and extraordinary contemporary relevance) is her observation that in the 1920's people in a number of countries began to

emphasize "the importance of good nutrition of children if they were to make the most of their educational opportunities." Citing a series of somewhat impressionistic studies which purported to show a cause and effect relationship between good nutrition and high scholastic attainment, she notes that while "we might be critical of their work today. . . their observations were partly responsible for getting cheap milk provided for children in schools in Britain, so they were important at a practical if not at a high scientific level."

Forty years later, as Ricciuti points out in his very useful review (1973), concern with the same issue of nutrition and intellectual attainment led to some equally questionable conclusions. "Rather prematurely," he writes, "research findings indicating an association between malnutrition and impaired intellectual functioning (were translated into) somewhat oversimplified and in some instances rather exaggerated conclusions concerning a direct causal relationship between nutritional deprivation and mental retardation."

And while the cause of truth still suffers the consequences of this premature positivism--discussions of hunger and education still contain an obligatory sentence regarding the probability that "permanent mental handicap" may be imposed on children by improper diet--yet the cause of humanitarianism was once again well served. "The threat of intellectual

impairment in malnourished infants has been a political petard breaking down resistance to maternal and child welfare feeding programs." (White, 1971)

As has become increasingly obvious, however, the links between malnutrition--even severe malnutrition--and mental development are quite elusive; research has now moved well beyond an exploration of the very global question: "does nutritional stress affect mental development?" to concern with a number of much more specific and researchable questions: 1) how does the duration, timing, and severity of malnutrition relate to its subsequent effects--if any? 2) are the effects of early malnutrition permanent or reversible? 3) if reversible what are the interactions between refeeding and environmental stimulation in the rehabilitation of the malnourished child? and 4) can malnutrition as a cause of impaired mental functioning be separated from the many other developmentally hazardous factors usually found in association with impaired nutritional status? (Nutrition, the Nervous System and Behavior, 1972; Roeder, 1973; Kallen, 1973.)

Looked at in a practical sense, in terms of opportunities for intervention, there are at least three parts to the question: does hunger and/or malnutrition affect children's learning? The first of these has to do with conditions before birth--namely can the undernutrition or malnutrition of a child's mother before conception or during pregnancy affect a child's subsequent intellectual status? Second, can severe malnutrition

early in post-natal life handicap a child mentally at school age--as a consequence of interfering with his learning at critical periods of development, through producing permanent impairment of brain structure or function, or through some other mechanism? And finally, is hunger in the classroom--leaving aside a child's or his mother's prior nutritional status--is present hunger a deterrent to present learning?

II PRENATAL NUTRITION AND INTELLECTUAL DEVELOPMENT

It is well known that poor women are more likely to be inadequately nourished during pregnancy than women who are not poor, and that their children are more likely to score poorly on intelligence and achievement tests (Caster, 1969). But such an association can tell us nothing about cause. Does nutritional stress [illegible] mothers affect the intellectual development of their offspring? There are two ways in which such a causal relationship has been tested. The direct method is to alter the nutritional status of the mother in some manner and see whether there is a parallel alteration in the mental development of her infant. The second, more indirect method is to show that there is a causal relationship on the one hand between an inadequate maternal diet and complications of pregnancy and birth; and on the other hand that exposure to abnormal pregnancies and births increases the risk of mental handicap for the children which are their product. Investigations

using both of these approaches have been reviewed elsewhere (Birch and Gussow--chapters 3 and 6).

For obvious reasons, direct assessment of the effect of maternal nutrition on intellectual outcome in humans can be undertaken experimentally only through improvement, not through disruption, of the mother's nutritional well-being. A greater difficulty, however, is that the outcome variable--the intellectual status of the child--is so far removed in time from the input variable--the changed nutritional status of the mother--that the possibility of drawing convincing conclusions is nil. One such early study (Harrell, 1956) in which mothers were given various dietary supplements in an attempt to influence the IQ's of their children, reported some mixed positive results but was virtually uninterpretable for the reason cited.

However an interesting (and hopefully unrepeatable) test of the opposite sort has been reported only recently (Stein, et al., 1972). It is what is euphemistically called an experiment of nature and is, in fact, an experiment made possible by man's inhumanity to man. The study involved looking at the adult intellectual attainment of a group of individuals whose mothers had been severely malnourished during pregnancy--specifically during the "hunger winter" in Holland toward the end of World War II. Because the famine was short-lived and had a clearly defined beginning and end, and because Holland has continuous medical records which made it possible to

trace into adulthood, persons born in this period, it was possible to examine the adult intellectual status of persons who had been born to mothers malnourished either through most of pregnancy, at the end only, or at the beginning only.

No differences in adult intelligence associated with maternal malnutrition were found. Lest such a finding be interpreted as suggesting that prenatal nutrition is not important, however, it should be pointed out that the population involved was quite well-nourished prior to the "hunger winter" and that all the infants, whenever they were born, were rehabilitated before the end of their first year of life--the period of maximum brain growth--since the famine had by then ended. Unfortunately, such are not the conditions under which poor mothers bear and raise their infants in peacetime.

The most testable association between prenatal nutrition and intellectual development in the offspring is the one that links the input and outcome variables through demonstrating that both are associated with complications of pregnancy and birth.

There is a long history of concern regarding the relationship between complications of pregnancy and birth and subsequent mental handicap. That literature is represented in this bibliography by a single paper (Pasamanick and Knobloch, 1960) from the investigators who did most to lay out the scope of that concern. They delineated what they called

a "continuum of reproductive casualty" related to complications of the reproductive process and ranging in severity from the death of the infant on the one hand to minimal defect on the other.

While a number of reproductive complications have been associated with increased risk of defective mental functioning in the child (Turkewicz, et al., 1968; Muller, et al., 1971; Rhodes, 1973) most attention has been given to the commonest and, in numbers affected, the most deadly of these complications, low birth weight (Birch and Gussow, 1970). Infants below five and a half pounds in weight at birth--especially those subsequently exposed to adverse environmental conditions (e.g., poverty)--appear to be at risk of retarded mental development, whether their low birth weight is a reflection of their "prematurity" or their retarded intrauterine growth (i.e. small-for-dates). (Drillien, 1970; Neligan, 1971; Lubchenco, et al., 1972)

The other link in the logic chain--the link between malnutrition or undernutrition in the mother and increased risk of low birth weight in infants--has received the official blessing of the prestigious National Research Council. Its Committee on Maternal Nutrition concluded after three years of study that there was a marked positive association between the mother's weight gain in pregnancy and the birthweight of her infant (Committee on Maternal Nutrition, 1970; Shank, 1970).

A number of research teams are presently attempting to test this apparent causal relationship with intervention studies. Preliminary results from two of these studies, one in Taiwan and one in Guatemala in which mothers' diets were supplemented during pregnancy (Blackwell, et al., 1973; Habicht, et al., 1973) tend to confirm the relationship. They suggest that appropriate nutritional intervention during the time the mother is carrying the fetus can increase birth weight significantly.

Although the diets of the women in these studies were supplemented throughout pregnancy, Bergner and Susser (1970) have reviewed the literature linking nutrition to pregnancy outcome and provided a rationale for supplementing pregnant women nutritionally as late as the third trimester of pregnancy--the time when many high risk women first appear for prenatal care. A study to test the usefulness of such belated intervention in raising birthweights is currently being conducted among low-income pregnant women in Harlem (Rush, et al., 1973), but results are not yet available. A failure to find positive results would not be surprising. The Guatemala data show that the mother's preconceptional nutritional status may be even more important than supplementation in affecting birthweight. Others have found that outcome may be affected by the mother's size--reflecting her own lifetime nutritional status--and that during pregnancy overall dietary quality may be an even more important determinant of birthweight than total weight gain

(Ademowore, 1972). These observations suggest that even the most vigorous short-term interventions may not fully compensate for generations of nutritional neglect. Since the overall association between prenatal diet and low birth weight appears to be established, however, as is the association between low birth weight and increased risk of intellectual dysfunction, it is clear that any intervention which can raise birth weight is likely to reduce the burden of mental handicap borne by poor populations among whom both prematurity and intellectual retardation are most frequent. (Amante, 1970)

III ANIMAL MODELS

Between prenatal and post-natal life is perhaps an appropriate place to consider briefly the many hundreds of animal studies which have attempted to tease out relationships between malnutrition and mental development. Much of what has been said about the effects of prenatal and postnatal malnutrition on the human mind has been based on extrapolation from animal studies, since animal young--in contrast to human children--can be genetically regimented, experimentally deprived, and otherwise manipulated so as to sort out the effects of nutrition per se from its social concomitants.

A very great number of studies have been done on various laboratory animals (with the rat leading in popularity) utilizing quantitative (calorie) or qualitative (protein) deprivation

imposed prenatally, postnatally, or both, and examining outcome variables ranging from brain cell number to emotionality and maze performance. Results from such studies prior to 1969 have been reviewed by Birch and Gussow (1970). They concluded that the data available to that time supported the following conclusions: 1) both brain size and composition, and performance on a variety of behavioral measures appeared to be affected by "various kinds and degrees of nutritional deprivation in young animals"; 2) the growth deficits as well as some of the behavioral and learning difficulties might persist even after refeeding and rehabilitation; and 3) intergenerational deprivation could lead to learning handicaps which "might persist even after a generation of refeeding--mimicking a hereditary condition."

A recent brief summary of the animal data put together by the NRC's Subcommittee on Nutrition, Brain Development and Behavior (Food and Nutrition Board, 1973) surveys a broader range of evidence to come to much the same overall conclusions. Experimentally-deprived animals show permanent changes in body and organ size, as well as reductions in brain weight and brain cell size and number; alterations in cellular organization and rate of myelination; alterations in the ratios between, and total amounts of, various brain components such as DNA, RNA, glycosides, lipids and certain enzymes, as well as changes in the amounts of neurotransmitter chemicals.

More careful behavioral studies have cast some doubt on prior reports of "learning disability" resulting from early nutritional insult, and have defined more clearly the kinds of behavioral changes which may have marked effects on test performance. Young malnourished animals are apathetic, like malnourished humans, and tend to avoid new stimuli in their environment--thus reducing their own opportunities for learning. Even after rehabilitation such animals may display elevated emotionality which can affect their performance on learning tasks. In animals, the behavioral effects of early malnutrition appear to be exaggerated when the nutritional deprivation occurs in concert with environmental isolation or restriction; and conversely, environmental enrichment seems able to partly compensate for early nutritional deprivation. Roeder and Chow (1972) have summarized a number of the animal findings.

In exploring further the inter-generational effects of undernutrition, Stewart (1973) has maintained a colony of rats for ten generations on a diet adequate for nonreproducing adults but inadequate for reproducing females. Successive generations of these chronically malnourished animals are described as tense, hyperactive, extremely nervous, showing head tremors, alterations in gait and delayed sexual maturation. Like other investigators, Stewart has found that it may take more than one generation of adequate nutrition to fully rehabilitate animals which have been intergenerationally deprived.

Effects on the brain appear to be most marked when malnutrition is imposed during the time of maximum brain growth--a vulnerable period which varies with the species being considered. (Dobbing, 1972) Malnutrition during periods of little growth or in adulthood after growth is completed, appears unlikely to have any lasting effects on brain structure or function.

There are a number of hazards inherent in attempting to translate results from animal studies such as these to the human condition. Coursin (1973) in his recent review of a conference on maternal nutrition, pointed out that where prenatal deprivation is concerned, these problems include: 1)the much greater severity of the malnutrition used in most experiments than that characteristically encountered among humans; and 2) the much greater proportion of the mother's body weight represented by the conceptus of a rat as compared with the conceptus of a human--and hence the much greater vulnerability of the former to nutritional deprivation.

Dobbing, in an eloquent plea for "more Critical Interspecies Extrapolation" (1973) has pointed out another problem. If one takes into account the respective brain growth spurts in animals and man, it appears likely that studies involving fetal malnutrition in rats may have no relevance whatsoever to neuronal growth in man, since such growth takes place in rats when the fetus is most vulnerable to nutritional deprivation and in man when it is most protected.

Animal studies, moreover, have been looked upon as "culture-free"--and therefore as models which allow for the assessment of malnutrition as an isolated stress. But available data (Levitsky and Barnes, 1973; Frankova, 1972) suggest that while "the animal model. . . may succeed in excluding genetic and social class variables, (it) cannot fully exclude variables other than nutritional ones." Malnutrition alters the behavior not only of the offspring, but of the mother as well, thus changing the whole nature of the inter-relationship between them in ways which could affect the physical and mental development of the young.

The ultimate limitation of animal studies lies in the difficulty of extrapolating meaningfully from animal to human behavior. Since the most important intellective functions in humans are those most animals did not possess to begin with, there is no way in animals to measure their loss. Subtle but significant alterations in human behavior cannot be assessed by the use of animal models. Thus while animal studies have been, and continue to be, of undeniable interest and importance to researchers in the field, they can never be, for educators, more than heuristic--nothing definitive about the toll of human deprivation on human intelligence can be demonstrated in animals in whom "it is not difficult to produce results which can easily be grossly misleading when uncritically interpreted for politicians, planners and grant-giving bodies." (Dobbing, 1973)

IV POST-NATAL MALNUTRITION AND MENTAL DEVELOPMENT

> The decision to investigate the effects of infant malnutrition on the developing brain imposes on the researcher an unusually high standard of social and scientific responsibility when it comes to interpreting his results; for the subject involves him in the interrelation between man's most important human faculty, that of higher mental function, and our greatest man-made scourge: the malnutrition of most of the world's children.
>
> J. Dobbing, 1973

There has never been any doubt that children suffering from malnutrition are at a disadvantage intellectually. A child suffering from marasmus, characterized by a severe shortage of calories, or kwashiorkor, in which the limiting nutrient is protein, is a critically ill child, and displays the apathy, inattention, withdrawal and, frequently, loss of appetite characteristic of desperately sick children. Such children used, quite regularly, to die. It was the survival of increasing numbers of these children in the developing countries, as a consequence of improved medical and nutritional care, that provided much of the impetus to the investigation of malnutrition and behavior.

Because of the obvious associations between brain and behavior, and because the brain is growing most actively during the time when severe malnutrition usually occurs--in the first three years of life--questions were early raised as to whether malnutrition might affect various parameters of brain growth and development. As has been noted, a great deal of animal

evidence was accumulated which said that it might. Brain analyses in humans are, of course, limited to necropsies on children who have died. Brown (1965), Chase et al. (1972) and Winick and his colleagues (Winick, M., 1970; Rosso, et al., 1970) have studied such material. They found some changes in the size and composition of children's brains similar to those found in malnourished animals, with the most marked changes occurring in the brains of those infants who were malnourished in infancy after being underweight at birth. Other investigators (e.g., Graham, 1967), using head circumference as an indicator of brain size, found that even after recovery from malnutrition severely malnourished children had smaller heads than children who had not been malnourished.

The difficulty, of course, with studies of brain size and composition is that little or nothing is known about the implications of changes in such measures for mental functioning. Japanese have smaller heads than Eskimos; and women, on the average, have smaller brains than men, which, as Dobbing (1973) has pointed out, cannot be assumed to be a handicap "unless for example one holds to the extraordinary doctrine that the somewhat smaller brain of women is the cause of their alleged mental inferiority to men."

To judge whether malnutrition has a permanent effect on mental functioning, as opposed to brain development, it is necessary to assess mental functioning in children who have been

malnourished. Studies which have attempted to do this have utilized two basic research strategies: 1) comparing the present intelligence of children who are known to have been hospitalized for malnutrition at some time in the past with the intelligence scores of a group matched for socioeconomic status, but with no history of hospitalization; and 2) comparing the behavior and/or achievement of tall and short children where height can be assumed to reflect prior nutrition.

Based on his review of studies of the first type, Ricciuti finds the evidence reasonably good that "severe protein malnutrition in the first year of life may have adverse effects on intellectual development in children." The persistence and severity of the impairment being reflective of the severity and duration of the deprivation. Chase (1973) comes to the same conclusion, though he emphasizes the difficulty of separating nutritional from other factors influencing child development.

Indeed, one difficulty with such studies is the selection of an appropriate control group. Even when socioeconomic status and other relevant variables are apparently controlled, there may be critically important differences in the "microenvironment" (Cravioto and DeLicardie, 1972) of children who do and do not become seriously malnourished. One of the earliest reported and most widely cited studies comparing undernourished with well-nourished children (Stoch and Smythe, 1963) failed to take into account the fact that the better-nourished control

group was better nourished partly as a consequence of attending a nursery school at which a meal was served. The malnourished children did not attend nursery school, lived in worse housing, had higher rates of parental unemployment and so forth. Under the circumstances it was difficult to ascribe differences in tested intelligence to differences in nutritional status.

Birch and his colleagues (Birch, et al., 1971; Hertzig, et al., 1972) have reported on two studies, one in Mexico and one in Jamaica which overcame this difficulty by comparing previously malnourished children with their siblings who had never been severely malnourished. They found significant differences in intelligence scores in favor of the controls. In the Mexican study more than twice as many of the previously malnourished children as their siblings had IQ scores below 70. In the Jamaica study the index (hospitalized) children were compared with like-sex siblings and like-sex school mates--the latter to control for the likelihood that in families where one child becomes severely malnourished the others may have been more moderately malnourished. On full scale, verbal and performance IQ measures the classmates scored highest, the index cases lowest, and the siblings fell in between.

It must be pointed out, however, that such studies have little relevance to circumstances in the United States where malnutrition severe enough to require hospitalization is notably rare. Only one small study of this type has been reported

in the U. S. (Chase and Martin, 1970) and most such studies have made use of populations from Asia, Africa and Latin America where severe malnutrition is, alas, not uncommon.

The second approach to assessing the effect of postnatal nutrition on intellectual development--that which uses height as an indicator of prior malnutrition would appear to have more relevance to the U. S. situation, since growth retardation was found in significant numbers of children examined for the Ten-State Nutrition Survey and has been reported among groups of disadvantaged children in this country by a number of independent investigators (Zee, et al., 1970; Brown and Halpern, 1971; Sanstead, et al., 1971; Ruffin, et al., 1972).

There is no obvious reason why height and intelligence ought to be related--sheer bulk is no virtue in thinking as it may be in football. Yet the observation that there is some kind of link between physical growth and educational achievement is actually an old one (Porter, 1895) and a broad one--"whether the picture is of the broad differences between rich productive countries and the underdeveloped regions, or between social classes in this or any other country, there is always a gradient with wealth in quantity and quality of diet associated with parallel gradients in rate of growth and adult stature, physical performance. . . mental ability, and resistance to disease." (Leitch, 1959)

Birch and Gussow, reviewing the data linking growth and nutritional status, showed that whereas there are obvious genetic differences in height potential between populations as well as between individuals, mean height differences between social class groups within genetically similar populations can be linked to differences in nutrition. Moreover, intergenerational changes in the height of whole populations (such as that in post-war Japan, or among immigrants to this country) and secular changes in growth patterns--in the developed countries growth has been speeded up and maturation comes earlier--have been related by a good deal of evidence to improved nutritional conditions. Thus size can, under a number of circumstances, be viewed as a record of prior nutrition.

The paper by Cravioto, DeLicardie and Birch (1966) provides a useful review of the relevant literature, as well as results from a study using height as an indicator of prior malnutrition. Children in a Guatemalan village where malnutrition was frequent were divided into quartiles by height for age and tested on various measures of intersensory integration. Children in the shortest quartile were found to score lowest, those in the tallest quartile the highest--while no such height-achievement relationship existed among children drawn from a well-nourished population where all children were presumably growing optimally and height was more likely to reflect genetic potential.

Ricciutti reviews several studies which have tended to confirm the association between height (i.e. nutritional history) and mental competence in children, but points out that alternate explanations for such correlations have been proposed. In the Cravioto study mothers of taller children tended to have higher levels of education than mothers of shorter children. Similar findings have been reported by Pollitt (1969); and Monckeberg, et al. (1972) found that mothers of taller children had higher IQ's.

Since more intelligent, better educated mothers may provide their children with better diets and more intellectual stimulation, no direct effect of nutrition on intelligence need be assumed.

In this country, attempts to relate height as a measure of past nutritional status with intellectual competence have met with limited success. Sulzer (1973) found an association between height and certain behavioral measures among a group of Head Start children in New Orleans, with the behavioral deficit being most marked among those children who combined evidence of past undernutrition (reduced height) with evidence of present malnutrition (anemia). The major behavioral change was reduced attentiveness and motivation and/or resistance to fatigue. But Brown and Halpern (1971) found no relationship between body size and intellectual measures among a group of poor black children examined in Mississippi; and Sanstead (1971) found

no correlation between a group of nutritional indicators (including height) and IQ among poor preschoolers in Tennessee.

Given the many factors which can affect both height and intellectual status, it is not surprising that no consistent association between them can be found. Even if there were a strong and inevitable association between height and mental development, it would be difficult to argue that they were linked solely, or even primarily, through a common association with nutrition. Malnutrition does not occur with frequency among children in well integrated families adequately supplied with every necessity and comfort except enough food. Children apt to be hungry are apt also to be exposed to a variety of other stresses--among them complications of the pregnancies which produced them, higher rates of undernutrition at birth, more illness which exacerbates and is exacerbated by a poor nutritional status, poor housing, poor sanitation, parental ignorance and neglect, poorer educational opportunities, and so on. In short, the risks for a poor child are multiple, interactive and probably cumulative. Prematurity, for example, appears to represent a much greater intellectual risk for a child born into a poor family than for a child born into a family that can provide an optimal early post-natal environment.

Hepner and Maiden (1971) concluded that most children among urban disadvantaged populations in this country, developed normally and that the children with growth failure, poor nutritional

status and borderline "emotional-behavioral-intellectual status" were those in whom the combined stress of "inadequate mothering" and a period of rapid growth had converted borderline dietary adequacy into frank insufficiency. In such a constellation of risk, the maternal inadequacy reflected in poor nutritional care is likely to be reflected as well in the mother's poor emotional response, her reduced interaction with the child and other behaviors antipathetic to optimum intellectual development.

Because so many questions remain unanswered, even in regard to the effects of severe malnutrition, a number of longitudinal field studies are currently in progress, the results of which should provide somewhat more convincing answers to the question of when and how malnutrition affects intelligence. Cravioto and his co-workers are in the midst of a longitudinal study in a Mexican village where they are following a cohort of children--enrolled in the study before birth--through the age of 6 or 7. The earliest results, (Cravioto and DeLicardie,1972) show that the language development of children who develop clinical malnutrition in infancy lags behind that of children matched for prior risk who do not develop malnutrition--but there is no published evidence as yet as to how long the deficit persists after recovery.

Once again the study, like most of the major ongoing studies, deals with a population at risk of severe malnutrition, and hence not comparable to the hungry children in the United States.

Given the much lesser degree of malnutrition likely to occur in this country, it is encouraging to learn from early results, that appropriate early intervention may be able to restore to full mental competence even children who have experienced severe nutritional stress. In Colombia (Latham and Cobos, 1971) and Guatemala (Klein, et al., 1973) major studies are underway to assess the long-term effect of supplementary food and health care on the growth and intelligence of malnourished children. No psychological test data has yet been published, but Klein's group found that growth rates of adequately supplemented children did not differ significantly from those of well-fed North American children.

Is the provision of adequate nutrition a sufficient intervention? At the time of the MIT conference (Scrimshaw and Gordon, 1967) it was already clear that many of the behaviors characteristic of malnourished children were similar to those which resulted from sensory deprivation. Reasoning from animal studies in which deprived or enriched environments had been shown to have effects on brain growth and development similar to those produced by poor or adequate nutrition, Levitsky and Barnes (1972) went on to demonstrate that in the rat at least, early environmental stimulation could overcome much of the behavioral deficit which early malnutrition produced.

Now Yaktin and McLaren (1970) have reported on a small study comparing the DQ's--Developmental Quotient--of two groups

of severely malnourished Arab children who were provided in the one case with ample food and medical care, and in the other case with the same food and care plus a stimulating environment. With recovery from acute malnutrition, both groups of children improved their DQ scores on the Griffiths Mental Development scale. However the stimulated group improved significantly more than the unstimulated group over the four month period, though "normal" levels of functioning were not attained.

McKay, et al. (1973) are well into a somewhat similar longterm study which will follow severely deprived Colombian children from the age of three until they enter school at six in an attempt to identify the kinds of interventions which might be effective in overcoming the effects of malnutrition. Their pilot studies seemed to indicate that children who received only nutritional supplementation and health care performed no better on a variety of tests of mental functioning than untreated sibling controls, though they showed positive gains on some affective-social measures--whose significance for later cognitive functioning is not yet assessed. However, malnourished children who received several hours of cognitive stimulation each day, in addition to food and medical care, showed improved performance on a variety of mental tasks.

Richardson has reanalyzed the data from the Hertzig, et al. Jamaica study (Richardson, 1972) and found that the malnourished children whose environments were relatively stimulating intellectually

functioned as well at school age on IQ measures as children who though not malnourished had grown up in a family which provided low intellectual stimulation.

These bits of evidence, while still tentative, begin to suggest that providing malnourished children with stimulation for their minds, as well as food for their bodies, may enable them to make up for infancies spent in environments which provided inadequately for both.

The studies summarized here have attempted to discover whether there is indeed a path leading from malnutrition in children to irremediable intellectual deficit. They were stimulated in part by the desire of scientists to create in the world at large a sense of urgency about feeding its starving children. If malnutrition in childhood can be proved to create a permanently retarded population, then feeding children becomes a first priority in nations looking toward full national development. The need for a sense of urgency has not declined. Hunger is perhaps even more prevalent than when the question first arose, and the issue of proper allocation of food even more critical. But data generated to create urgency elsewhere were--in this country--on the verge of being used to counsel despair. Children whose mothers were ill-fed, or who were themselves ill-fed in early childhood might--we were warned--suffer a permanent reduction in the number of their brain cells or in the critical interconnections between them. If we did not remedy these children's

hunger in time, it was argued, they might come to school permanently and severely retarded. As the intervention data suggest, such a concern may not even be justified in countries where near-starvation among children is common; in this country such concern is a distraction. It is quite evident from the studies reported to date that if malnutrition is to cause what can be described as mental retardation, it must be early, prolonged and relatively severe. Other than in highly exceptional circumstances such conditions do not exist in the United States.

V HUNGER AND MENTAL DEVELOPMENT

> In the United States there is a good deal of discussion about malnutrition, but an inadequate focus on the problems of hunger. Hunger implies relative deprivation and stigmatization as well as lack of sufficient intake of nutrients. Hunger may be just as, or even more debilitating than malnutrition, but the elimination of hunger may well involve social restructuring. Because society is either unable or unwilling to deal with hunger, or with the conditions associated with its development, there has been a focus on problems of malnutrition as politically and socially expedient.
>
> Kallen, D., 1973

Hunger is not malnutrition. The severely malnourished child is often not hungry. The very hungry child may or may not be malnourished in ways that are measurable. "The school child who frequently misses breakfast or lunch," Ricciutti has pointed out, "may perform poorly because of inattentiveness and distractability associated with hunger. However, these potential influences on school performance and learning, about

which we know very little, clearly need to be differentiated from those effects which are the result of long-term protein-calorie malnutrition."

In the United States we are, or ought to be, much more concerned about the hunger or chronic subnutrition which afflicts too many of our children than about severe malnutrition of the kind that afflicts children in less fortunate parts of the world. Yet unless a child is severely malnourished, it is often difficult to assess his nutritional status in a meaningful way. Which, together with Kallen's analysis supra, may help to explain the quite remarkable lack of published data relating children's hunger to their intellectual development or school achievement.

Where subclinical levels of malnutrition are involved, as Gussow wrote in 1970, "the hard scientific evidence to support the notion that children's present biological condition correlates with their learning is best described as fragile. . . For what it is worth (the few studies available) have all tended to show that children who were better nourished did better. But the fact remains that there are. . . no controlled studies which show whether the child who is very hungry is unable to work as well as one who is not hungry--or even whether he is just unwilling to."

There are a number of impressionistic reports (If We Had Ham. . . etc., 1971), from teachers in schools which have initiated breakfast programs, to the effect that children who

have had breakfast are easier to teach, more attentive and less quarrelsome. But data from a recent unpublished study showed no significant differences in attentiveness and test performance among children who did or did not have "breakfast" (150-200 calories of "something"), or among another group which did or did not have a mid-morning snack. (Dwyer, 1972) Sulzer as has been noted found small decrements in certain performance variables among anemic children, and in another unpublished study some improvement on certain measures of psychological functioning has been found among children receiving meals at a Head Start Center. The evidence, in short, is still fragile. The NRC summary (Food and Nutrition Board, 1973) finds it "surprising that little or no objective or solidly planned research concerning hunger and the behavior of children has been reported."

In the absence of such evidence ought educators in this country to conclude that the question of whether children are hungry--or even moderately malnourished--is educationally unimportant? That would be an inappropriate conclusion. It is true that there is no scientific evidence to suggest that our children's minds are being permanently damaged by the physiological effects of nutritional deprivation--though as we have pointed out mothers' poor nutrition and poor nutritional history may well be contributing significantly to children's handicap. Yet it is necessary always to keep in mind the distinction between the kinds of answers really needed, and the kinds of

answers sometimes sought. "From a practical point of view," Barnes has written, "it is important that studies with malnourished children emphasize the interactions between nutrition and environment rather than attempt complex costly experiments which hopefully will assess the contribution of each alone." (1972) When one is dealing with something less than severe malnutrition Ricciuti points out "the particular contribution of nutritional factors relative to the role played by concomitant social and environmental influences is not at all clear." What is clear is that the experience of growing up in this country under social conditions sufficiently adverse to produce hunger or malnutrition is an educational handicap.

"Poverty is stigmatizing," says Kallen, "and because hunger has become a polite synonym for the poor it too is stigmatizing. In addition, for the child, hunger can be as de-energizing as severe malnutrition. If the child must spend his time worrying about having enough to eat, he will have neither the energy nor the attention available for learning. This condition, in turn, will create expectations about his abilities which will prompt differential treatment by his teachers and lowering of his educational rank in already insufficient school systems. Thus he will be cut off from the opportunities for educational attainment necessary for entry into an occupational structure where educational attainment is increasingly required. . . Without the ability to enter into meaningful occupational

positions. . . he is unlikely to have the resources to prevent his children from being hungry. Thus the cycle perpetuates itself." (Kallen, 1973)

In this country, it is almost foolish to ask whether hunger and malnutrition interfere with learning. A negative answer would not, surely, lead us to conclude that it is therefore all right for children to remain unnecessarily hungry. Whether or not a mother's hunger or that of her children produces an irremediable intellectual deficit--which seems increasingly unlikely--or whether the effect of hunger is limited to its present effect on attitude, motivation, attention or some other psychological factor, the reason for feeding poor children and their mothers in the richest country the world has ever known is because they are hungry. And as Kallen (1973) points out, "Permitting children to be hungry in the midst of affluence violates crucial moral norms."

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